# Observed changes in the lipid profile and calculated coronary risk in patients given dietary advice in primary care

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*SUMMARY*

***Background.*** *Dietary advice is usually the first-line treatment for increased blood cholesterol in primary care with a reduction in levels as the expected response. In practice, the diet adopted by the patient may lead to changes in blood lipids characterised by a greater decrease in high-density lipoprotein (HDL) than total cholesterol. The ratio of total cholesterol to HDL cholesterol is an important factor in calculated coronary risk using the Framingham model, from which most risk tables currently in use have been derived. This suggests that either coronary risk may increase after dietary advice or that risk should always be assessed on measurements made before any intervention has taken place.*

***Aim.*** *To report observed changes in blood lipids and calculated coronary risk following dietary advice in primary care.*

***Method.*** *Subjects with at least one coronary risk factor and baseline cholesterol above 5.2 mmol/l from an inner-city general practice had cardiovascular risk factors, including fasting lipids, recorded before receiving dietary advice. At follow-up several months later, risk factor measurements were repeated. Ten-year coronary risk was calculated using the Framingham model. Lipid levels and coronary risk at baseline and follow-up were compared.*

***Results.*** *There was a significant decrease in both total cholesterol and HDL cholesterol in both sexes. However, in 56% of subjects, HDL decreased by a greater proportion than the total cholesterol. These subjects showed a highly significant increase in the total cholesterol/HDL cholesterol ratio (median = 0.8 [semi-interquartile range = 1.5], $P<0.001$, which was correlated with a change in triglycerides ($r_s = 0.309$, $P<0.001$). In those who had an increase in the total cholesterol/HDL cholesterol ratio, calculated coronary risk increased from 5.45% (13.2) at baseline to 7.25% (15.5) ($P<0.001$). In all subjects, the change in calculated coronary risk associated with dietary advice ranged from -15% to 15%.*

***Conclusions.*** *Low fat dietary advice in this primary care setting was frequently associated with undesirable changes in the lipid profile. The majority of subjects showed an increase in the total cholesterol/HDL cholesterol ratio, owing primarily to a decrease in HDL. Consequently, calculated coronary risk increased in over one-half of the subjects. Owing to our incomplete understanding of HDL metabolism, it is unclear whether the fall in HDL is actually detrimental; however, it seems prudent to give dietary advice to patients to avoid excess simple carbohydrate as a fat substitute. This helps avoid a rise in triglycerides, which appears to be associated with an increase in the ratio. These results confirm that coronary risk should always be calculated using measurements made before intervention.*

*Keywords: dietary advice; cholesterol; high-density lipoprotein; calculated coronary risk.*

## Introduction

DIETARY advice is usually given as a first-line coronary prevention measure in general practice, often before a formal assessment of coronary risk is made. One of the authors (DP) observed that dietary advice given in primary care appeared to have surprising results on blood lipids as many patients showed an increase in the total cholesterol to high-density lipoprotein (HDL) cholesterol ratio. As this ratio has a strong relationship with coronary events,[1,2] it appeared that dietary advice may have been conferring greater coronary risk in these patients.

Several tables [3] have been devised using the Framingham model[4] to calculate absolute coronary risk based on the subject's lifelong exposure to levels of coronary risk factors. This model includes the total cholesterol to HDL cholesterol ratio and any changes, even if they are small, markedly alter the calculated coronary risk. Although, in the clinical trial situation, dietary modification shows a favourable decrease in the total cholesterol to HDL cholesterol ratio,[5,6] low fat diets may lower not only low-density lipoprotein (LDL) but also HDL cholesterol[7] and consequently the ratio. In practice, outside the clinical trial, despite appropriate advice often reinforced by diet sheets, there is little control over the nature of dietary modification initiated by the patient. Consequently, a change in the quantity and quality of dietary fat will alter the ratio of total cholesterol to HDL cholesterol with an effect on calculated coronary risk.

The aims of this study were threefold. First, we wanted to quantify changes in blood lipids associated with dietary advice in primary care. Secondly, as we were particularly interested in changes in the total cholesterol to HDL cholesterol ratio, we sought to explain how changes in diet might give rise to an altered ratio. Thirdly, we assessed how dietary change modified calculated coronary risk through altering levels of risk factors.

## Method

The study took place over a two-year period in an inner-city

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practice in Stoke-on-Trent, North Staffordshire, where coronary heart disease mortality is 20% higher than the national average. Screening and recording coronary heart disease (CHD) risk factors was an established practice policy and patients with one or more risk factors had a fasting (12 hours) sample taken for cholesterol (total and HDL) and triglyceride levels. Total cholesterol and HDL cholesterol concentrations were analysed at the Department of Biochemistry, North Staffordshire Hospital. The laboratory analyses were precise with coefficients of variation for total cholesterol and HDL cholesterol of 3.2% and 6.1% respectively.

All of the subjects selected for this study were free of coronary disease, conditions or drugs likely to effect the lipid profile and none had received previous dietary advice. Those with total cholesterol greater than 5.2 mmol/l were invited to attend for dietary advice broadly in line with the recommendations of the British Hyperlipidaemia Association.[8] The subjects were interviewed one-to-one with the practice nurse, who suggested changes to their existing diet with the aim of reducing the fat content by substituting saturated fats with polyunsaturated fats. A supplementary and commonly used diet sheet, devised by the Family Heart Association, was also provided. This consists of a food list that categorises foods into those to eat frequently, those to eat occasionally, and those to avoid altogether.

Absolute percentage coronary risk during the next 10 years was calculated using the risk factor measurements made before and after dietary advice. The calculation was the widely used Framingham model,[4] which includes the subject's age, sex, systolic blood pressure, the presence of left ventricular hypertrophy, diabetes mellitus, smoking habit, and the total cholesterol to HDL cholesterol ratio. Five patients had one item of data missing and were excluded from the analysis of coronary risk.

The statistical significance of changes in the lipid parameters following dietary advice was assessed by Wilcoxon's signed rank matched pair test. The relationship between these changes and the length of follow-up was tested using Spearman's ranked correlation. Patients were then categorised according to whether the total cholesterol to HDL cholesterol ratio was increased or decreased. Differences in the lipid parameters between these two groups were tested statistically using the Mann–Whitney U-test. As data were not normally distributed the results were expressed as median and interquartile range (IQR).

## Results

### *Subjects studied*

Two hundred and ten patients with one or more risk factors were screened; the 59 (28%) who had a total cholesterol of less than 5.2 mmol/l were not followed up in this study. Eight (5%) of the remaining 151 patients failed to attend for a second blood test after dietary advice and one patient died soon after the initial screening leaving 143 patients. The median interval from baseline to follow-up was eight months (IQR = 2 months) and 111 (78%) subjects had repeat blood tests within 12 months of the initial assessment.

### *Baseline parameters and changes following dietary advice*

The 143 patients comprised 83 (58%) males (median age = 49 years [IQR = 20 to 69 years]), and 60 (42%) females (median age = 51 years [IQR = 20 to 75 years]). Of these, 27.2% of males and 16.7% of females were smokers and hypertension (systolic greater than 160 mmHg, diastolic greater than 90 mmHg) was present in 40% of both sexes. CHD risk factors in others included being overweight (body mass index greater than 25kg/m$^2$), a poor diet or a family history of premature CHD. At follow-up there was no significant change in smoking habit, alcohol consumption, medication, body weight or blood pressure. The blood lipid levels before dietary intervention are displayed in Table 1. The median cholesterol was 6.6 mmol/l in both sexes, slightly above the national average. The total cholesterol to HDL cholesterol ratio was higher in men owing to their lower HDL concentration. At follow-up, total cholesterol had fallen by 0.6 mmol/l (median, IQR = 0.7 mmol/l) in males and 0.6 mmol/l (median, IQR = 0.9 mmol/l) in females ($P$<0.001 for both). The corresponding HDL cholesterol had decreased significantly by 0.2 mmol/l (median, IQR = 0.3 mmol/l) in men and 0.3 mmol/l (median, IQR = 0.4 mmol/l) in women ($P$<0.001 for both). There was no significant change in triglyceride in either sex.

### *Changes in the total to HDL cholesterol ratio*

There was no overall change in the total cholesterol to HDL cholesterol ratio following dietary intervention in either sex. But, when individual patients were considered, it was seen that the ratio remained unchanged in two patients, increased in 56% (48 male and 32 female), and decreased in the remaining 43% (34 male and 27 female). There was no significant relationship between the change in the ratio and its initial level, indicating that the changes were not simply regression towards the mean value. Additionally, time trend analysis showed no significant correlation between the change in the ratio with the time interval between the initial and final lipid measurements ($r_s$ = -0.082). As there was no significant difference between males and females in the change in the ratio, results from both sexes were combined for further analyses.

Patients were categorised into two groups depending on whether the total cholesterol to HDL cholesterol ratio increased (median = 0.80 [IQR = 1.5]) or decreased (median = -0.62 [IQR = 0.8]) (Table 2). The group with a decrease in the ratio had a fall in total cholesterol and LDL cholesterol with no change in HDL cholesterol. This group also showed a significant fall in triglycerides. However, the group with an increase in the ratio had a small fall in total cholesterol associated with a proportionately greater decrease in HDL cholesterol. In this group, triglycerides increased from baseline levels. This increase from baseline was not statistically significant, but there was a highly significant change in triglycerides compared with those whose ratio decreased ($P$<0.001). Correlation analysis showed that the change in the ratio was significantly related to the change in triglycerides ($r_s$ = 0.366, $P$ = 0.001).

### *Dietary advice and calculated absolute coronary risk*

Absolute coronary risk was calculated in 138 patients. The median risk at baseline was 7.7% (IQR = 14.9%) with a non-significant increase to 8.5% (IQR = 14.6%) at follow-up (median difference = 0.172% [IQR = 3.76%]). The distribution of change in risk for all individual subjects is shown in Figure 1. The maxi-

**Table 1.** Lipid results before, and the total cholesterol to HDL cholesterol ratio before and after, receiving dietary advice. Results given as median (interquartile range).

| | Males (n = 82) | Females (n = 61) |
|---|---|---|
| Total cholesterol mmol/l | 6.6 (1.4) | 6.6 (1.5) |
| HDL cholesterol mmol/l | 1.2 (0.5) | 1.6 (0.6) |
| LDL cholesterol mmol/l | 4.4 (1.3) | 4.4 (1.3) |
| Triglycerides mmol/l | 2.1 (2.1) | 1.3 (1.15) |
| Total cholesterol/HDL | | |
| Initial | 5.46 (2.77) | 4.00 (1.70) |
| Final | 5.50 (2.96) | 4.23 (2.12) |

**Table 2.** Patients classified according to the increase and decrease in the total cholesterol to HDL cholesterol ratio. Results given as median (interquartile range).

| | Increase ratio (male = 48) (female = 32) | Decreased ratio (male = 34) (female = 27) | Significance of difference between groups |
|---|---|---|---|
| Total cholesterol | -0.6[a] (0.8) | -0.7[a] (1.0) | 0.0065 |
| HDL cholesterol | -0.3[a] (0.2) | 0 (0.3) | <0.001 |
| LDL cholesterol | -0.2[a] (0.7) | -0.6[a] (0.7) | <0.001 |
| Triglycerides | 0.1 (0.8) | -0.2[b] (0.7) | <0.001 |
| Weight | 0 (2.0) | 0 (3.0) | NS |

Significance of change from baseline: [a]P <0.001; [b]P <0.01; [c]P <0.05.

imum change was 15% in either direction. The subjects who had an increase in the total cholesterol to HDL cholesterol ratio had a median 10-year risk of 5.45% (IQR = 13.2%) at baseline, increasing significantly ($P$<0.001) to 7.25% (IQR = 15.5%) at follow-up. Those who had a decrease in ratio had a higher baseline risk of 11.3% (IQR = 13.5%) but this decreased significantly ($P$<0.001) to 9.4% (IQR = 9.2%) at follow-up. Calculated coronary risk increased in only 12% of patients showing a decrease in the ratio and, conversely, risk decreased in only 5% of those who had an increase in ratio. This shows that the changes in calculated coronary risk were mainly owing to changes in the total cholesterol to HDL ratio.

## Discussion

Our observations were that, at follow-up, despite a significant fall in the median values of both total cholesterol and LDL cholesterol, HDL cholesterol may also be significantly reduced leading to an increase in the ratio of total cholesterol to HDL cholesterol. In our study, the ratio was increased in more patients than it was decreased.

The direction of the change in the total cholesterol to HDL cholesterol ratio depended on the relative changes in total cholesterol (reflected by the LDL) and HDL cholesterol levels. In subjects with a decrease in the ratio, LDL cholesterol fell without a change in the HDL cholesterol. However, in those with an increase in the ratio, a small decrease in LDL was accompanied by a larger decrease in HDL. The correlation analyses in this study suggested that the changes in the ratio were related to altered triglyceride levels. This fits with the known reciprocal relationship between triglycerides. Dietary fat substitution by carbohydrate increases triglyceride synthesis[3,6] and could account for the increase in triglyceride concentration we observed.

The total cholesterol to HDL cholesterol ratio is extensively used in the calculation of coronary risk from tables[3] derived from the Framingham model that we have recently shown to be valid for the United Kingdom Caucasian population.[9] This study at face value suggests that, in over half of the patients, dietary intervention has not been beneficial and may even result in harm. The results of studies of dietary advice on lipid levels, particularly HDL, vary, While one report showed no change in HDL irrespective of who gave dietary advice and how it was given,[10] in another HDL decreased with a fall in the mean ratio, although it is not clear in how many patients the ratio was increased.[11]

Recent studies suggest that CHD protection by HDL may result from a high rate of turnover rather than its blood level. Studies in animals show that up-regulation of the HDL receptor (SR-B1),[12] which may be achieved with polyunsaturated fatty acids,[13] increases HDL cholesterol turnover and reduces it blood level,[14] yet suppresses atherosclerosis.[15] Until the implication of dietary reductions in HDL are more fully understood it seems

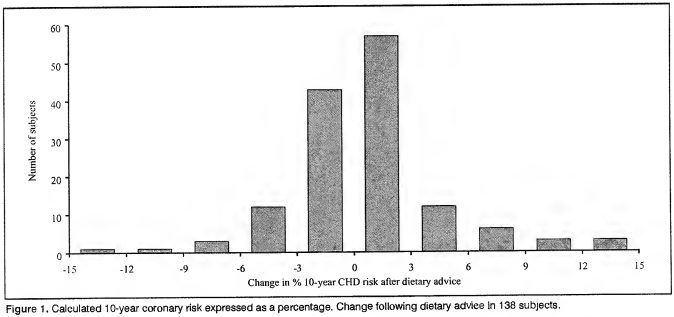


Figure 1. Calculated 10-year coronary risk expressed as a percentage. Change following dietary advice in 138 subjects.

prudent to follow measures suggested in recent reports aimed at maintaining the level of HDL cholesterol by encouraging a low fat diet together with weight loss[16] and replacing saturated with monounsaturated fat[17] or high-fibre carbohydrate-rich foods[18].

Clearly, more randomised controlled trials are needed to explore this issue and the nature of our study design limits any conclusions we may draw on the relationship between dietary advice, dietary change, and lipid metabolism. However, the value of our study lies mainly in that it was carried out in a 'real world' setting; it is an exploration of what actually happened with patients given dietary advice to reduce CHD risk. It is unclear whether an increase in the ratio is detrimental to coronary risk in light of our incomplete understanding of HDL metabolism at present. However, it is important to be aware that low fat dietary advice may not provide the desired effect on the lipid profile in the majority of patients. The ratio is known to provide a reliable index of coronary risk before intervention and this result should be used when calculating absolute coronary risk. Prudent dietary advice should then perhaps be provided only to patients at high risk of CHD, as a recent meta-analysis shows a statistically significant reduction in coronary risk only in this group. This approach would avoid inflicting an unproven[18] but potentially unpalatable change in lifestyle for little gain.[19]

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